

Topic 16 Reproduction

16.1 Asexual Reproduction

Definition: **Asexual reproduction** is a process that results in the production of **genetically identical offspring** from a **single parent**. It involves only one organism and no fusion of gametes.

Examples of Asexual Reproduction: Examples include binary fission in bacteria, budding in yeast, and vegetative propagation in plants (e.g., runners in strawberries, tubers in potatoes, bulbs in onions).

Advantages and Disadvantages of Asexual Reproduction

Context	Advantage	Disadvantage
To a Population (in the wild)	Rapid colonisation of a stable environment. Only one parent is needed, making it efficient.	Lack of genetic variation , making the entire population susceptible to a single disease or environmental change.
To Crop Production	Guaranteed production of high-quality, genetically uniform crops (e.g., all bananas are identical). Faster maturity and quicker yield .	High vulnerability to a single pest or disease outbreak, which can wipe out the entire crop.

16.2 Sexual Reproduction

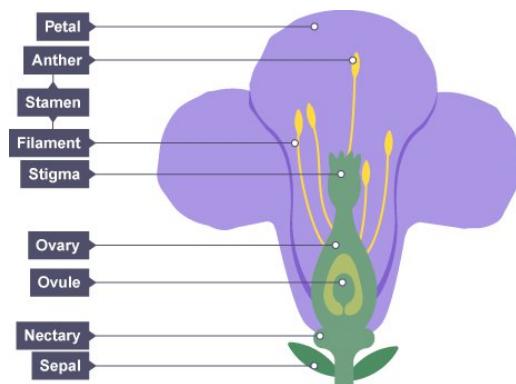
Definitions:

- **Sexual reproduction** is a process involving the **fusion of the nuclei of two gametes** (sex cells) to form a **zygote**, producing **genetically different offspring**.
- **Fertilisation** is the process where the **nucleus of a male gamete fuses with the nucleus of a female gamete**.
- **Gametes** are the male and female sex cells (e.g., sperm and egg in animals, pollen nucleus and ovule nucleus in plants).
- **Zygote** is the single cell formed after fertilisation.

16.3 Sexual Reproduction in Plants

Structure of a Flower

The flower is the reproductive organ of a plant. The syllabus requires identification and knowledge of the function of the following parts:



Part	Function
Sepals	Protect the flower bud before it opens.
Petals	Often large, brightly coloured, and scented to attract insects for pollination.
Stamens	The male reproductive part, consisting of the anther and filament.
↳ Filament	Stalk that holds the anther up.
↳ Anthers	Produces and contains pollen grains (the male gametes).
Carpels (Pistil)	The female reproductive part, consisting of the stigma, style, and ovary.
↳ Stigma	Sticky surface that receives the pollen grains .
↳ Style	Stalk that connects the stigma to the ovary; the pollen tube grows down it.
↳ Ovary	Contains the ovules (which contain the female gametes). The ovary develops into the fruit.
Ovules	Contain the female gametes and develop into seeds after fertilisation.

Structural Adaptations of Insect- and Wind-Pollinated Flowers

Feature	Insect-Pollinated Flower	Wind-Pollinated Flower
Petals	Large, brightly coloured, often scented.	Small, dull, or absent.
Nectaries	Present, producing nectar to reward insects.	Absent.
Pollen Grains	Fewer in number, large, sticky, or spiky to attach to insects.	Large numbers, small, light, and smooth to be easily carried by the wind.
Anthers	Stiff and firmly attached, often inside the flower.	Loose and dangling on long filaments, often outside the flower to release pollen easily.
Stigma	Small, sticky, and often enclosed within the flower.	Large, feathery, and exposed to catch pollen from the air.

Pollination and Fertilisation in Plants

- **Pollination** is the transfer of pollen grains from the anther to the stigma.
 - **Self-pollination:** Transfer of pollen from the anther to the stigma of the **same flower** or another flower on the **same plant**. (it relies less on pollinators and requires less energy)
 - **Cross-pollination:** Transfer of pollen from the anther of one flower to the stigma of a flower on a **different plant** of the same species.

Pollination Type	Effect on Variation	Effect on Population Adaptation
Self-pollination	Leads to less genetic variation (inbreeding).	Less able to adapt to changes in the environment due to a lack of variation. (less resilience against disease)
Cross-pollination	Leads to more genetic variation (outbreeding).	More able to adapt to changes in the environment due to a wider gene pool.

- **Growth of the Pollen Tube and Fertilisation:**
 - 1 A pollen grain lands on the stigma.
 - 2 It germinates, growing a **pollen tube** down the style towards the ovary.
 - 3 The pollen tube enters the ovule through a small hole.
 - 4 The **pollen nucleus fuses with the nucleus in the ovule** (fertilisation).
 - 5 The fertilised ovule develops into a **seed**, and the ovary develops into a **fruit**.

Seed Germination

Seed germination is the process by which a seed begins to grow into a new plant.

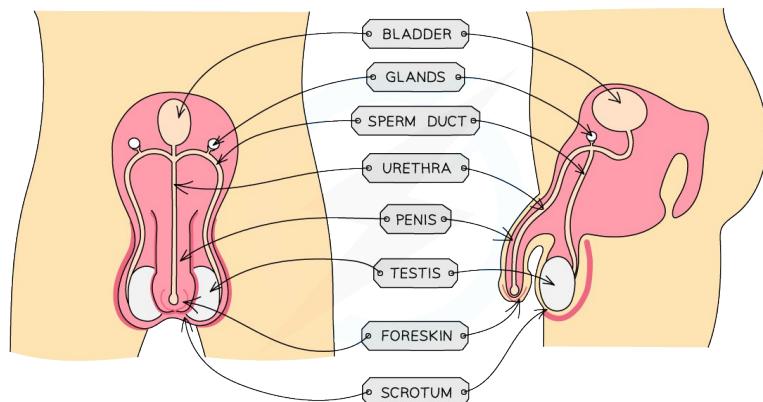
Conditions for Seed Germination: The three essential conditions for germination are:

- 1 **Water:** To activate enzymes and transport dissolved food substances.
 - 2 **Oxygen:** For aerobic respiration to release energy for growth.
 - 3 **Suitable Temperature:** For the optimum activity of the enzymes involved in germination.
-

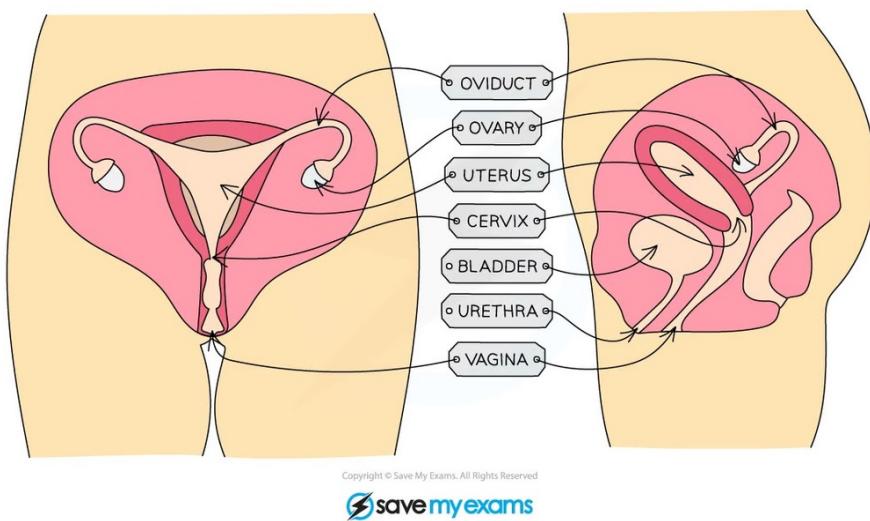
16.4 Sexual Reproduction in Humans

Structure and Function of the Reproductive Systems

Part	Male Reproductive System Function
Testes	Produce sperm (male gametes) and the hormone testosterone .
Scrotum	Sac that holds the testes outside the body, maintaining a temperature lower than body temperature for optimal sperm production.
Sperm Ducts	Tubes that carry sperm from the testes to the urethra.
Prostate Gland	Produces a fluid that mixes with sperm to form semen , providing nutrients and a fluid medium.
Urethra	Tube that carries semen (and urine) out of the body through the penis.
Penis	Organ used to pass urine and transfer semen into the female vagina during sexual intercourse.



Part	Female Reproductive System Function
Ovaries	Produce egg cells (ova, female gametes) and the hormones oestrogen and progesterone .
Oviducts (Fallopian Tubes)	Tubes that carry the egg from the ovary to the uterus. Site of fertilisation.
Uterus (Womb)	Muscular organ where the embryo implants and fetus develops during pregnancy.
Cervix	Ring of muscle at the entrance to the uterus, keeping the fetus in place during pregnancy.
Vagina	Muscular tube leading from the cervix to the outside of the body; receives the penis during sexual intercourse.
Urethra	Carries urine out of the body



Gametes and Fertilisation

- **Fertilisation** is the fusion of the nucleus of a sperm with the nucleus of an egg (ovum) to form a **zygote**. This typically occurs in the **oviduct**.
- The **zygote** then divides repeatedly to form an **embryo**, which travels to the uterus and **implants** itself into the thickened uterine lining.

Adaptive Features of Gametes

Gamete	Adaptive Features
Sperm	Flagellum (Tail): For movement (motility) towards the egg. Mitochondria: Provide energy (ATP) for the tail's movement. Enzymes (in acrosome): Digest the outer layers of the egg cell to allow the sperm nucleus to enter.
Egg (Ovum)	Large size: Contains a large store of energy/nutrients for the initial development of the zygote/embryo. Jelly Coat: Changes structure after one sperm enters to prevent other sperm from entering (polyspermy).

Comparison of Male and Female Gametes

Feature	Sperm (Male Gamete)	Egg (Female Gamete)
Size	Very small.	Very large (largest cell in the body).
Structure	Head, mid-piece (mitochondria), and flagellum (tail).	Spherical, surrounded by a jelly coat.
Motility	Motile (can move).	Non-motile (cannot move on its own).
Numbers	Produced in very large numbers (millions).	Produced in small numbers (one per menstrual cycle).

Development of the Fetus

After implantation, the embryo develops into a **fetus**. The fetus is supported by several structures:

Structure	Function
Placenta	Organ that allows the exchange of substances between the mother's blood and the fetus's blood, it also produces progesterone during pregnancy.
Umbilical Cord	Connects the fetus to the placenta, containing blood vessels that transport substances to and from the fetus.
Amniotic Sac	Membrane that encloses the fetus.
Amniotic Fluid	Fluid inside the amniotic sac that surrounds the fetus. Its functions are to: 1. Act as a shock absorber to protect the fetus from mechanical injury. 2. Maintain a constant temperature for the fetus. 3. Allow the fetus freedom of movement for muscular and skeletal development.

Function of the Placenta and Umbilical Cord (Exchange of Substances)

The placenta facilitates the exchange of substances between the mother's blood and the fetus's blood via diffusion, **without the bloodstreams mixing**.

- **Substances passing from Mother to Fetus:**
 - **Dissolved nutrients** (e.g., glucose, amino acids, vitamins).
 - **Oxygen** (for respiration).
 - **Antibodies** (for passive immunity).
- **Substances passing from Fetus to Mother (Excretory Products):**
 - **Carbon dioxide**.
 - **Urea** and other metabolic wastes.

Harmful Substances Crossing the Placenta: The placenta is not a perfect barrier. Some **pathogens** (e.g., the virus that causes Rubella, or HIV) and **toxins** (e.g., alcohol, nicotine from smoking, certain drugs) can pass across the placenta and affect the fetus, potentially causing birth defects or miscarriage.

16.5 Sex Hormones in Humans

Role of Hormones

- **Testosterone (Male Hormone):**
 - Causes the development of the **male primary sexual characteristics** (development of testes and penis).
 - Causes the development of **male secondary sexual characteristics** at puberty (e.g., growth of facial and body hair, deepening of the voice, increased muscle mass, sperm production).
- **Oestrogen (Female Hormone):**
 - Causes the development of the **female primary sexual characteristics** (development of ovaries, oviducts, and uterus).
 - Causes the development of **female secondary sexual characteristics** at puberty (e.g., widening of hips, development of breasts, onset of the menstrual cycle).
 - Plays a crucial role in regulating the **menstrual cycle**.

The Menstrual Cycle

The menstrual cycle is controlled by four key hormones: Follicle-Stimulating Hormone (FSH), Luteinising Hormone (LH), Oestrogen, and Progesterone. FSH and LH are produced by the **pituitary gland** in the brain, while Oestrogen and Progesterone are produced by the ovaries.

The menstrual cycle is a monthly cycle of changes in the female reproductive system, typically lasting about 28 days.

Days	Changes in the Uterine Lining	Changes in the Ovaries
Days 1–5	Menstruation (period): The thickened uterine lining breaks down and is shed. Hormone Levels: The pituitary gland secretes FSH , which stimulates an ovarian follicle to start maturing. Oestrogen and Progesterone levels are low.	A new egg begins to mature in an ovarian follicle, stimulated by FSH.
Days 6–13	The uterine lining starts to thicken again and becomes richly supplied with blood vessels. Hormone Levels: Rising Oestrogen (produced by the developing follicle) stimulates the repair and thickening of the uterine lining + inhibiting FSH.	The egg continues to mature within the follicle.
Day 14 (approx.)	-	Ovulation: The mature egg is released from the ovary into the oviduct. Hormone Levels: A surge in Luteinising Hormone (LH) triggers ovulation.
Days 15–28	The uterine lining continues to thicken, maintained by Progesterone (produced by the Corpus Luteum), ready for implantation. If no fertilisation occurs, the corpus luteum degenerates, Progesterone levels drop, and the cycle restarts.	The empty follicle develops into the Corpus Luteum , which produces Progesterone and some Oestrogen.

16.6 Sexually Transmitted Infections (STIs)

Definition: A **Sexually Transmitted Infection (STI)** is an infection that is transmitted from an infected person to an uninfected person through **sexual contact**, including intercourse.

HIV/AIDS:

- **HIV (Human Immunodeficiency Virus)** is a **pathogen** that causes an STI.
- HIV attacks and destroys the white blood cells (lymphocytes) of the immune system, leading to **AIDS (Acquired Immunodeficiency Syndrome)**.
- AIDS is the final stage of HIV infection, where the immune system is severely compromised, making the person vulnerable to opportunistic infections and cancers.

Methods of HIV Transmission: HIV is transmitted through the exchange of certain body fluids:

- 1 **Unprotected sexual intercourse** .
- 2 **Sharing of contaminated needles** (e.g., by drug users).
- 3 **Blood transfusions** with infected blood (rare in countries with screening).
- 4 **From an infected mother to her child** (during pregnancy, birth, or breastfeeding).

Control of STIs (including HIV): The spread of STIs can be controlled by:

- 1 **Abstinence:** Avoiding sexual intercourse.
- 2 **Using barrier methods:** Such as **condoms**, which prevent the exchange of body fluids.
- 3 **Reducing the number of sexual partners** (monogamy).
- 4 **Screening and treatment** of infected individuals and their partners.
- 5 **Education and awareness** campaigns about safe sexual practices and transmission routes.
- 6 **Antenatal screening** of pregnant women for HIV and other STIs.